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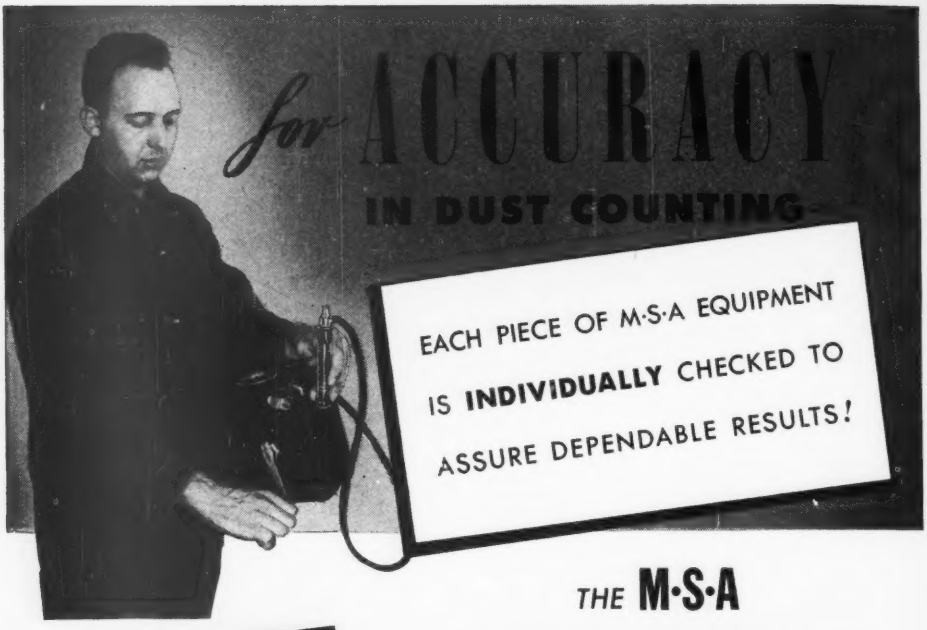
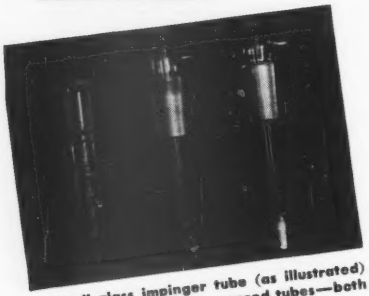
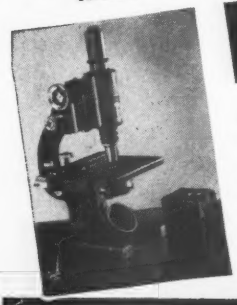
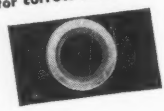




New all-glass impinger tube (as illustrated) and standard rubber-stoppered tubes—both carefully checked for correct flow.





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Hydrogen Cyanide as an Industrial Hazard
Methods of Detection and Control

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ALTHOUGH THE incidence of poisoning by hydrogen cyanide is relatively low under modern methods of protection, it is an ever-present potential danger to workers in various processes. The danger lies in the rapidly fatal action of HCN and the narrow margin that exists between a safe and a lethal level in the atmosphere. It is well known and cannot be overemphasized that the salts of cyanide, upon exposure to acids, liberate free hydrogen cyanide gas in lethal concentrations, but the literature of toxicology contains little practical information on the many existing hazards from this source, which are revealed to the users of cyanide only through sad experience. For example, it is not generally recognized that hydrogen cyanide gas can be evolved from the solid salts and from all salt solutions of cyanide in which free caustic is not present; they do not need to come in contact with acid. In a closed system the CO_2 in the air will displace HCN and the air concentration of HCN will approach and eventually equal twice the original CO_2 concentration. Normal air contains approximately 0.03%, or 300 ppm. of CO_2. The fact that a solution gives an alkaline reaction is not an indication that it will not evolve HCN. A solution composed of 1 gm. NaCN dissolved in 100 cc. of distilled water in itself has a pH of 11.0.

Pharmacology

WITHIN THE mammalian organism cyanide has a double action. First, it directly affects the respiration to a degree varying with the concentration. In low concentrations it acts through the reflex nerve control and is the most effective stimulant known to pharmacologic or medical science. However, this stimulation is fleeting and unimportant in industrial hygiene. In higher concentrations, cyanide causes inhibition of the respiratory center in a manner identical with that of respiratory paralysis due to oxygen deficiency. This action may be the final cause of death in cyanide poisoning. Secondly, it inactivates the enzyme which utilizes oxygen in tissue respiration, and death results from asphyxia even though the blood may be saturated with oxygen. It is this effect on oxygen exchange that makes cyanide so rapidly fatal. Physiologic detoxification within the body, is accomplished by conversion of the toxic cyanide ion into the nontoxic thicoyanate, which is rapidly excreted in the kidneys. By this means the body is capable of maintaining a normal oxygen balance even when exposed to cyanide concentrations of 20 to 40 ppm. over an eight-hour period. It also is capable of preventing death from a single ingested dose of 80 mg. of sodium cyanide or its equivalent in any other form. If, however, the safe level is increased to such an extent that the ability of the organism to detoxify it is overwhelmed, the poison will accumulate within the system and produce tissue anoxia. An atmospheric concentration of only 100 to 240 ppm. is dangerous to life in thirty to sixty minutes.

The initial symptoms of poisoning are vasodilatation with a generalized sensation

of warmth followed by reddening of the skin. There is a temporary feeling of exhilaration. This is soon succeeded, in order, by prostration; nausea and vomiting, often with headache; dyspnea and a feeling of constriction around the chest; unconsciousness, respiratory paralysis and death. In severe exposure there is a rapid succession of coma, convulsions, and death, which may occur in five minutes or less. After convulsions have begun there is no effective treatment. When breathing has ceased but the heart still beats, the prompt application of artificial respiration holds out a faint hope. If the patient is still able to breathe, removal to fresh air usually is sufficient to assure recovery.

Because of its rapidly fatal action and of the narrow boundary between safe and dangerous atmospheric concentrations, all persons concerned with the use of cyanide should have a thorough knowledge of its potentialities and of the safeguards that have proved most effective.

Methods of Detection and Control

ANY PROGRAM for control of the cyanide hazard in industry should incorporate the following features: (1) Selection and instruction of employees; (2) Adequate medical facilities; (3) Sound methods of engineering; and (4) Routine plant surveys.

1. Employee Selection and Instruction: No individual having any abnormality of the heart or blood pressure should be employed on a process involving cyanide because of the fact that amyl nitrite, the specific antidote for cyanide poisoning, is likely to aggravate these conditions.

Every exposed individual should be completely informed as to the potential danger involved, the early symptoms of poisoning, and the emergency measures to take in case of accident. This instruction should be given in such a way as to dispel exaggerated fear and at the same time establish a well founded respect for the possibility of poisoning. He should become acquainted with the almond-like odor of the substance by actually smelling it and should be informed that this odor is perceptible even when the concentration in the atmosphere is entirely within safe limits. In order to demonstrate the rapid effects of high concentrations, mice may be placed in a small jar inverted over a screen-covered solution of 1% NaCN. After five minutes, the observers are shown that the mice are dead and at the same time they may be permitted to smell the solution. This demonstration will prove not only the rapidity of death from cyanide inhalation, but also that an alkaline solution can generate a lethal concentration.

It should be emphasized that whenever the employee is in any doubt as to the safety of remaining in an atmosphere contaminated with HCN, he should get out of it immediately and stay out until the concentration has been checked quantitatively. Even though concentration is the all-important factor in the time vs. concentration relationship, when the concentration is unknown time becomes the more important consideration and the length of exposure should be kept to a minimum. The premonitory symptoms of poisoning vary widely with the length of exposure, the percentage of cyanide in the atmosphere, and whether it has increased suddenly or gradually. The only early symptoms that seem to be common to all cases, of whatever degree, are a feeling of light-headedness and a disordered breathing, or simply the awareness of breathing. When these are experienced, the individual should immediately go out into the fresh air.

In a large workshop, a dangerous amount of HCN entering the atmosphere at one point will not immediately be diffused throughout the room, and all employees should be instructed as to the proper emergency measures to take in the event that any one of them is seen to collapse at his work. It is essential that they learn how to give artificial respiration before coming on the job. It should be emphasized that the life of an individual exposed to cyanide in high concentration depends upon his immediate removal to an uncontaminated atmosphere. Medical aid must be obtained at once. Meanwhile if the patient has ceased to breathe, artificial respiration should be promptly instituted and continued without a moment's cessation until the patient begins to breathe again or is pronounced dead by a physician. On no account must the rhythmic movements of pressure and release be interrupted before such time, and hours may be required to re-establish normal breathing. Amyl nitrite pearls should

be readily available for inhalation by the patient who is able to breathe.

2. Adequate Medical Facilities: Every plant using cyanide should either have on its staff or within easy reach a doctor or nurse who is familiar with the existence of the cyanide hazard, who can instantly diagnose cyanide poisoning, is well versed in its treatment, and has at hand the necessary equipment and solutions for any such emergency. The most satisfactory medical treatment for acute cyanide poisoning is the intravenous injection of $NaNO_2$ and sodium thiosulfate.*

3. Sound methods of engineering are of particular importance in plants using cyanide. A process using cyanide should never be carried out in congested enclosures or in rooms with a low ceiling. In chemical processes wherein hundreds of pounds of cyanide may be held in solution in one reaction vessel, sufficient ventilation should be provided to maintain safe working conditions in the event that the entire potential volume of cyanide gas were to be released into the working area in the shortest time theoretically possible. Facilities for ventilation should be provided at every possible source of gas leakage or liquid exposure. In addition to spot ventilation, general ventilation arrangements should provide for a rapid rate of complete air exchange. All ventilating fans should be equipped with an alarm to indicate failure of operation.

4. Surveys of all areas involved should be carried out at regular intervals and quantitative determinations made of the cyanide concentrations existing at each point in the process. Face and duct velocities of all ventilating facilities should be checked at regular intervals. A record of these rates will provide the information necessary for mechanical maintenance of the ventilating system.

Any good text on industrial hygiene will outline several methods for the determination of cyanide in the atmosphere. Jacobs[1] gives a detailed description of eight methods, three of which are adaptable for field use, but these are far from being completely satisfactory and are given only as methods of detection. Anyone attempting to calibrate the benzidine copper acetate, the methyl orange mercuric chloride, the simultaneous or the Prussian blue test soon recognizes his shortcomings. Some industries reportedly hang strips of methyl orange indicator paper around and recommend it as a means of cyanide detection, but the fact is that you can breathe all day on methyl orange indicator paper and it will not turn red. There are 30,000 ppm. of CO_2 in expired breath, yet they apparently expect to detect dangerous levels of cyanide with it.

Robbie and Leinfelder[2-3] have described the use of phenolphthalin and $CuSO_4$ in a disodium phosphate buffer, with the addition of caustic following the sampling period. In the Industrial Hygiene Research Laboratory of Merck & Company, we have modified this method as to the amounts of reagents used and have substituted trisodium phosphate for disodium phosphate buffer.

This eliminates any need for the addition of caustic, and the end-point color can be observed as it develops during the sampling time required to produce it. The test solution is placed in a midget impinger tube for spot sampling in areas of unknown concentration.

See Errata Page 15 Vol. 10

Field Procedure for Spot Sampling

PREPARATION of Stock Solution (Solution A): Dissolve 0.166 Gm. Phenolphthalein in 75 cc. ethyl alcohol $(C_6H_4OH)_2 CH C_6H_4 COOH$. Dissolve 0.33 Gm. $CuSO_4 \cdot 5H_2O$ in 100 cc. distilled water. Mix these two solutions and bring to 200 cc. volume with distilled water.*

Preparation of Buffer Solution (Solution B): Dissolve $Na_3PO_4 \cdot 12H_2O$ in distilled water (2.5 Gm. per liter).

Preparation of Test Reagent: Place 2 cc. of Solution A in 98 cc. of Solution B.**

Preparation of Standard: Dilute 10 cc. of the Test Reagent to 50 cc. with Solution B and add a small grain of sodium cyanide. Use 10 cc. of this in a midget impinger tube and the color developed is that produced by sampling:

*For the details of treatment (K. K. CHEN, C. L. ROSE and C. H. A. CLOWES) *J. Am. Pharm. A.*, 24:625-630, August, 1935.

*Refrigerated storage of this reagent will maintain its stability for an indefinite period (never less than a week). The development of a slight color when made up for use in Test Reagent indicates the need for making a fresh solution.

**The Test Reagent is stable for 8 to 24 hours, after which time it may develop a slight color. However, this does not interfere with the sensitivity of the reagent.

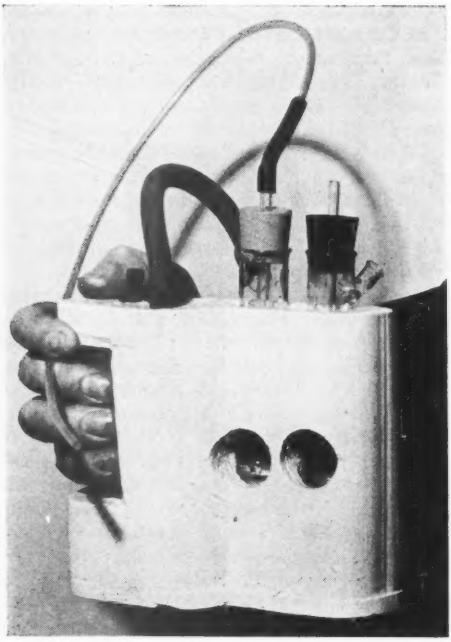

Fig. 1.
Apparatus used for field sampling of HCN. Unit contains rubber aspirator bulb (65cc. per each bulb compression), and two impinger tubes. Sample can be taken and results observed using only one hand.

2000 cc.	of	air	containing	10 ppm.	HSN
1000 cc.	"	"	"	20 "	"
500 cc.	"	"	"	40 "	"
250 cc.	"	"	"	80 "	"
125 cc.	"	"	"	160 "	"
75 cc.	"	"	"	320 "	"

through 10 cc. of the Test Reagent.
250 cc. (Maximum for 30 min.)
125 cc. (Dangerous for 30 min.)
75 cc. (Fatal in 5 min.)*

Field Sampling Method: Place 10 cc. of Test Reagent in a midget impinger tube and aspirate a known volume of air through it until the color matches the standard.

*Substances that interfere with the test are chlorine, bromine, iodine, phenol, and high concentrations of hydrogen sulfide. If the atmosphere has a high acid concentration the pH of reagent should be checked after 1000 cc. has been sampled. This may be done by adding 1 drop of Phenolphthalein indicator. (Phenolphthalein is the common indicator used in acid-base titrations.) The solution should turn red.

Phenolphthalin Reagent chemical may be obtained from Eimer & Amend, New York; Fisher Scientific Co., Pittsburgh, Pa.; or Eastman Kodak, Chemical Division, Rochester, N.Y.

The color change during the sampling period in concentrations of 40 ppm. or under gives results well within 10% error and enables an individual to safely enter an area of unknown concentration if he holds his breath during the exposure. If after sampling 100 cc. he can detect no color change he may resume breathing. If 200 cc. does not develop the end point, he can advance into the area and remain there safely for five minutes.

For continuous analysis of the atmosphere, the same solution as used in the spot test method is prepared in a quantity of 5 liters for an eight-hour sampling period, and is introduced at a controlled rate of 10 cc. per minute into a controlled air sampling rate of 1 liter per minute. Following intimate mixing the reagent is continuously collected and passed through a colorimetric photocell unit. Two micro switches are set to sound a bell at 20 ppm. and a horn at 60 ppm. With a 40 foot sampling distance there is a 30 second lag due to sampling time and a 30 second additional lag for the solution and recorder changes to reach the warning point when the concentration is changed instantaneously from 0 to 20 ppm. at the point of sampling.

Summary

CASES OF industrial poisoning by cyanide are rare, but even one preventable death per decade is too much. Prevention requires a thorough understanding of the danger of cyanide, whether in solid form or solution and with or without contact with acids. It requires careful engineering and periodic surveys of the work rooms to determine and locate any dangerous exposures. Since the cyanide hazard is increased by the narrow margin that exists between a safe and a lethal concentration of the gas in the atmosphere, perhaps the most important element in prevention is an accurate procedure for determining these concentrations. A field sampling procedure and a method for continuous analysis were found highly efficacious in our laboratory.

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2. ROBBIE, W. A. and LEINFELDER, P. J.: Cyanide Determinatins, Rapid and Simple Method for Measuring Small Amounts of Cyanide Gas in Air. *J. Ind. Hyg. & Tox.*, 27:136-139, May, 1945.

3. KATZ AND LONGFELLOW: *J. Ind. Hyg.*, 5:97, 1923-4.

Transport Velocities For Industrial Dusts
An Experimental Study
(Preliminary Report)

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LEONARD GREENBURG, M.D., Executive Director
ARTHUR C. STERN, Chief Engineer
Division of Industrial Hygiene and Safety Standards
New York State Department of Labor

REFERENCES in industrial hygiene engineering contain only limited information on the subject of minimal transport velocities of industrial dusts. The lists found in Alden[1] and Witheridge[4] are fairly comprehensive, but still fall short of the needs of the profession. The formulas derived by DallaValle[6] for minimal transport velocities were based on observations made on only four dusts of very limited size range.

Common practice has been to design exhaust systems employing main velocities ranging from 3500 to 4500 LFM. Experience has shown that velocities of these magnitudes are sufficiently high to keep the mains clean.

In recent years doubt as to the validity and economy of the accepted high transport velocities has been felt because of the many systems which were found to have clean pipes with materially lower air velocities than the published standards. Lower velocities will reduce the pressure loss and abrasion in the pipe. It is definitely good engineering to design for as low a velocity as practicable. Hatch[7] has shown the economy of low velocities for certain types of dust control systems. In these low velocity systems the dust is not transported through the mains by air flow but is allowed to settle in plenums to be removed manually at intervals or continuously by automatic means. This type of system is not applicable to all industrial installations and usually involves greater care and expense of maintenance than the conventional transport system with which we are dealing in this discussion.

There is a need for experimental data on a large number of different dusts for the purpose of providing information which can be used by the industrial hygiene engineer. In order to gain these data on minimal transport velocities we have instituted a long term program of investigation. This paper is a preliminary report on 28 industrial dusts which we have studied up to the present time.

Experimental System Layout

THE EXPERIMENTAL system consists of six-inch round pipe in the form of a "U." The pipe is open to the atmosphere at the feed end. At the opposite end there is a cloth dust collector and a fan to provide air flow. A diagram of the system is shown in Fig. 1. Control of air volume is obtained by means of a blast gate in the fan outlet and another in the bleeder line located before the collector. The test dust is fed into the system through a funnel connected to the main duct by means of a two-inch pipe six inches from the open end of the main duct. Thus the dust inlet is at the vena contracta. This insures an initial velocity higher than that in the main run of pipe. Transparent sections of cellulose acetate were located as shown in the figure. These were approximately 24 inches long. In addition, a transparent end cap was located in the upper section of pipe and provided with an external mirror and an interior light. The metal pipe was standard riveted and soldered construction, but the transparent sections and the glass cap at the bottom of the vertical run were held on and sealed with tape for easy removal for cleaning and replacement.

The dust used in our studies was collected from various industries, usually being taken from cyclone or cloth collectors, and in some cases from the machines producing the dust. Sizing was by means of a series of eight standard screens. The size distribution was plotted on log probability paper from which the median size was obtained.

A modification of the Westphal balance was used for the determination of the den-

No.	Description	DUST: Method of Collection	DUST: Method of Production	Density	Median Size in.	VELOCITIES - TEST: Bounce	Roll	Vert.	Horiz.	Pick up	Clean	RECOMMENDED TRANSPORT VELOCITIES: Alden[1]	Bull.[2] 217	Brandt[3] Table E	Brandt[3] Table 11	Witheridge[4]	Authors' Results
22	Aluminum chips	Cyclone	Grinding	2.72	.0132	3800	3000	2200	1670	850	2200	4000	4000	(3500 (4500	5000	4500	4000
1	Asbestos	Cloth	Saw	2.20	.0138	1900	1560	1210	1120	1020	1500					3000	2000
4	Casein	Cyclone	Lathe & sanding	1.27	.0070	1370	1210	680	605	605	1270	3000					1600
15	Catalin	Machine hopper	Lathe & sanding			1820	1250	1250	910	1020	1610	3000					2000
5	Foundry, non-ferrous	Machine	Wheelabrator	3.02	.0046	2800	2340		1450	1130	1650	3500		4000	5000	3500	3100
17	Foundry, ferrous	Cloth	Tumblers	2.52	.0092	1570	1430	1100	920		1300	3500		4000	5000	(3500 (4000	1800
25	Grain	Cloth	Blast cabinet	1.41		2500	2400	2300	1300	700	1950	2000	2000		3000	2000	2800
26	Lead oxide	Cyclone	Mixer	8.26	.00058			1130	1130	1500	3050						3400
11	Leather - shavings	Cyclone	Edge trimmer	1.34	.054	1880	1640	1590	1450	1400	2380	3000			4000	3000	2700
2	Leather - sanding	Cyclone	Sanding	1.32	.021	1330	1270		920	1120	1120	3000			4000	3000	1500
8	Limestone, coarse	Precleaner	Drilling	2.83	.0057	2410	1750	1390	1310	1210	1530					3500	2700
12	Limestone, fine	Dynamic Precip.	Drilling	2.78	.0028	1420	1420	1340	1190	1260	1720					3500	1600
19	Litho powder	Cyclone		1.94	.0048	610		360	360	910	1270						1400
20	Litho bronze	Cyclone		4.44	.0082	1570	1350	1350	1030	970	1620						1800
7	Metal (alum. & bronze)	Cyclone	Grinding	6.34	.0039	2730	2600	1310	1310	1020	1560	3000	2200	(3500 (4500	4000	3000	3100
30	Rosin	Machine	Hog		.020	3900	3900	2500	1670	780	1890						4000
3	Rubber	Cyclone	Grinding	1.14	.060	2000	1390	1390	1390	1450	1800	2000	2000		3000	2000	2200
28	Starch			1.27	.0025	1300		1300	1300	350	2300						2600
21	Steel shot blasting	Cloth	Blast cabinet	6.85	.0038	2500	2420	1810	1520	910	1900	3500		4500	4000		2800
23	Steel shot blasting	Cloth	Blast cabinet	4.61	.0172	1500	1320	1320	1180	1020	2180	3500		4500	4000		2400
9	Vinyl	Cyclone	Grinding	1.82	.0064	2020	1830	1270	1270	1120	1390	3000					2300
6	Wood flour	Machine	Sanding		.012	1560	1390	1170	1080	1080	1390	1500		3500		2000	1800
27	Wood hog dust	Machine	Hog		.023	3750	3300	1350	1350	850	1900	3500				3500	4000
10	Wood sawdust, heavy	Machine	Tumbling barrel		.055	2950	2220	1700	1500	1340	1620	3000	2000	3500	4000	3000	3300
16	Wood sawdust, light	Machine	Table saw			2400	1730	1270	1210	1080	2000	2000	2000	3500	3000	2000	2700
18	Wood shavings, hard wood	Cyclone	Planer			2150	2000	1700	1100	910	1770	3000	3000	3500	4000	3500	2400
14	Wood shavings, soft wood	Machine	Matcher			1590	1450	1130	1020	1220	1550	3000	3000	3500	4000	3500	1800
29	Wood composition, chips	Machine	Hog	1.18	.054	3900	3050	2100	1270	780	1560	3500					4000

[1] Design of Industrial Exhaust Systems. John L. Alden. Industrial Press. 1939.
[2] The Determination and Control of Industrial Dust; Public Health Bull. 217. J.J. Bloomfield & J.M. DallaValle. 1938.
[3] Industrial Health Engineering. Allen D. Brandt. John Wiley & Sons, Inc. 1947.
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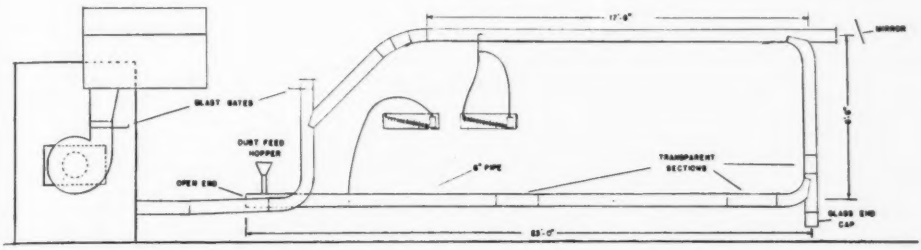

Fig. 1.
Dust Transport Study Layout

sities of the dusts employed in this study, except in the case of those dusts (wood, etc.) which floated on top of the toluene employed as the test fluid.

The duct system was calibrated at various air flows by means of a 12 point traverse with a pitot tube in the upper horizontal pipe and a permanent static suction reading seven diameters from the open end, using an inclined gauge. A straight line relationship between velocity and static suction was obtained by plotting on double log paper, so that in actual use it was necessary only to read the static suction in order to determine the average velocity of air flow.

Test Method

THE DUSTS were fed into the system manually at a uniform slow rate, starting with a high air velocity and reducing the air flow in small steps. The action of the dust was observed through the transparent sections and in the interior of the pipe by means of the mirror at the end. As the air velocity was reduced the following critical points of dust behavior were noted: (1) Beginning to bounce in horizontal pipe, (2) Beginning to roll or slide in horizontal pipe, (3) Beginning to settle in vertical pipe, (4) Beginning to settle in horizontal pipe, (5) Complete settling in horizontal pipe.

After complete settling, the air flow was slowly increased and the velocities at which the dust began to be picked up and at which the settled dust was completely removed from the pipe were noted. This last point can be called the velocity for adequate cleaning.

Although dust cannot be completely airborne in a long enough pipe, we considered a dust airborne as long as there was no noticeable bounce in the transparent sections. The first critical velocity, that of "bounce," was defined as the highest velocity at which a definite bounce and rebound of the dust particles were observed.

The second critical point, the "roll" velocity, was taken as the velocity at which the dust just began to roll or slide along the bottom of the pipe. The "settle" velocities are self-explanatory.

Settling from the vertical pipe was noted by the deposition of dust in the glass end cap at the bottom of the vertical pipe. We do not regard this observation as being very reliable since turbulence due to the connection into the vertical pipe was seen as the cause of some particles being thrown down, even at high velocities

With heterogeneous dusts of wide size range and in some cases mixed materials, some of the critical points were not clearly defined. For example, with a given dust it was observed that fine particles were completely airborne, medium particles bouncing, and heavy particles rolling or even starting to settle, all in a single run at a fixed velocity. In these instances, the tests were repeated with different observers in order to reduce the observational errors as much as possible.

Test Results

THE TEST RESULTS are summarized in the table. This table also shows our recommended minimal transport velocities for the dusts studied. The results indicate that the vertical settling velocity is uniformly lower than the "bounce" velocity, and is closely related to the "roll" velocity. In general, the adequate pick up velocity is close to the roll velocity, except for certain

dusts which when settled tend to pack in the bottom of the pipe. For these dusts which pack, such as the lead oxide and the starch dusts, much higher velocities are required to pick up settled material than are necessary to keep the same material airborne.

Transport velocities must not only be based on keeping the material "airborne," but also on adequate pick up and cleaning of dust which may have settled due to improper operation of the exhaust system. For this reason, the authors' recommendations are based on the "bounce" velocity or the velocity required to clean the pipes, whichever is higher. The highest test velocity for each dust was arbitrarily increased 10%, to allow for excessive turbulence in the piping, and then rounded off to the next higher hundred. In all cases, our recommendations for the dusts studied will maintain the dust airborne and will also provide adequate pick up and cleaning if necessary.

It is to be noted that our recommendations are for minimal safe transport velocities, not design velocities. Actual design velocities should not be less than these minimal transport velocities, but may be greater, according to the judgment of the design engineer. The actual design velocities must take into account such factors as the use of blast gates, chip traps, probable poor maintenance, and the possibility of picking up material other than that for which the exhaust system is designed.

Summary

A PRELIMINARY investigation of transport velocities on 28 dust samples reveals that lower velocities than previously published may be satisfactory for a number of materials. The work will be continued with many more dusts from different processes in order to amass more information of value to engineers in the field of industrial hygiene.

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COMPLETE details on a device for continuously recording the concentration of nitrogen in gas mixtures by photoelectric means are contained in a report now available from the Office of Technical Services of the Department of Commerce. The nitrogen meter, developed by the University of Pennsylvania under government contract for the evaluation of oxygen supply systems used in high-altitude flying, is expected to have other applications in the field of analytical gas chemistry. "The Nitrogen Meter" by John C. Lilly and Thomas F. Anderson is a 32-page report including illustrations and diagrams. It is available from the Library of Congress, Photoduplication Service, Publication Board Project, Washington, D.C., at $5.00 in photostat, $2.25 in microfilm.

Health Problems of X-Ray Shoe Fitting

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A STUDY OF 43 of the estimated 200 x-ray fluoroscopic shoe fitting machines in the city of Detroit showed that the majority of the devices were potentially capable of excessively exposing both shoe store employees and customers to x-ray. Experiments showed that the devices could be made safe according to present knowledge of tolerance to radiation by reducing the primary beam intensity to 12r per minute and providing filtration of 1 millimeter of aluminum, improving tube enclosure and limiting customer exposure to five viewings of five seconds each per day and 20 such viewings per year. Detailed regulations for the safe operation of the shoe fitters are given.

The rapidly expanding use of x-ray fluoroscopic shoe fitting has introduced the potential hazards of ionizing radiations to a significantly large group of workers in retail shoe stores. Industrial hygiene studies of these devices have not been reported in detail.*

An estimated 750 workers are exposed to the 200 installations believed to exist in the city of Detroit. This investigation reports a study of 43 such installations in which 125 workers were exposed.

Description of X-Ray Shoe Fitting Machines

VARIOUSLY known as x-ray shoe fitting machines, fluoroscopic shoe fitters, or simply x-ray shoe fitters, owners report that they are used to scientifically aid in the proper fitting of shoes, to promote shoe sales, or to meet competition. They consist of five functional parts: an x-ray tube, a fluorescent screen, a transformer, a timing mechanism and a starting mechanism. These parts are contained within a wooden cabinet (Fig. 1) which has an opening for the customer's feet between the tube and the screen, and three openings on the top for the purpose of viewing the screen.

*An ordinance regulating their use has been established by the New York City Department of Health.

The x-ray tube is enclosed, either wholly or partially within a box usually made of steel or lead lined wood. Some very old machines may have no tube enclosure other than a leaded rubber jacket around the spherical part of the tube. One manufacturer supplies a sealed unit with the tube immersed in oil, while the others are all air cooled. No cones are supplied on any models, but instead a large opening on the top of the tube enclosure permits unfiltered radiation to strike the foot platform, usually at a distance not greater than eight inches nor less than three inches from the target. Usual operating conditions for the x-ray tube are 50 kilovolts and 1-7 milliamperes.

The transformer on many machines is placed adjacent to the tube enclosure and constitutes the enclosure wall on that side. This construction is very often responsible for much leaking radiation, as failure to fit the enclosure and transformer closely together will leave large open slits.

The chamber wherein the feet are placed is a major source of stray radiation around any machine, for of necessity this opening must be rather large. A sheet of leaded glass above the screen prevents much of the radiation from reaching the top of the cabinet, but scattered and secondary emanations from the foot chamber can be of considerable magnitude.

Primary X-Ray Beam Intensity

IT WAS REALIZED early in the investigation that in addition to the stray radiation hazard some consideration must be given to the possibility of injury to customer's feet through excessive exposure to the strong primary rays. Although damage to the "patient" is not usually a matter of concern to the industrial hygienist, the difference to be noted here is that non-technical and non-medical personnel are using the x-ray equipment, and hence any reliable measure of control of this factor must

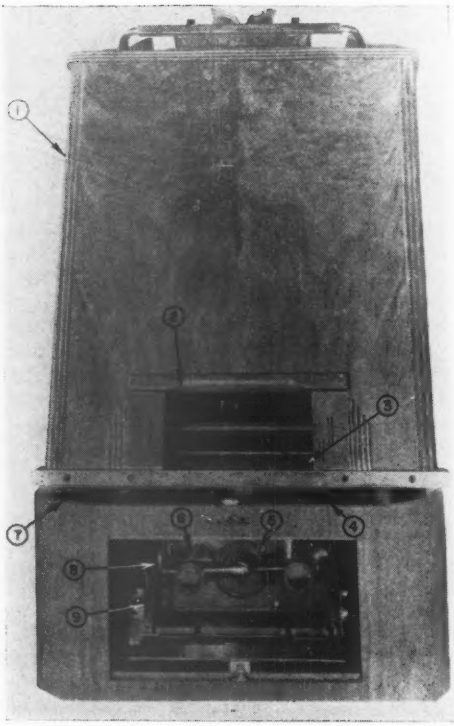

Fig. 1.
X-Ray Shoe Fitting Machine. (1) Cabinet (2) Fluoroscopic Screen (3) Foot Chamber (4) Interlock Switch (5) X-Ray Tube (6) Mounting Brackets (7) Platform (8) Aluminum Radiator (9) X-Ray Tube Enclosure

be accomplished largely by safeguards built into the equipment. To assist in arriving at a maximum permissible dosage, several conferences were held with local radiologists and roentgenologists. It was agreed that the erythema dose could not be used as a working limit, for internal damage is theoretically possible long before erythema appears. The limit finally established resulted from the application of an appropriate safety factor to the usual value of 0.1r per day used for stray radiation. Because of the intermittent nature of shoe fittings insofar as the customer is concerned, the limiting value had to be expressed in terms of both single exposures and cumulative exposures over a suitable period of time. The practical side of fitting a pair of shoes also had to be considered, for a limiting value that did not include this factor would be impractical.

A typical machine was studied in the laboratory of an x-ray equipment company to determine the minimum beam intensity that would give a satisfactory image under various conditions. Decreases in the roentgen output were obtained by varying the primary voltage, milliamperage and filtration. A summary of this study is shown in Table I.

TABLE I.

Conditions	Filtration MM Al	Roentgens* per Min.	Quality of Image
1. Primary voltage 110 Milliamperage 3.2 **Type screen B	none	42.6	Good
2. Same	0.5	32.5	Good
3. Same	1.0	26.0	Good
4. Same	1.5	21.6	Good
5. Primary voltage 110 Milliamperage 1.2 Type screen B-2	1.5	8.6	Good except for thick soles
6. Primary voltage 108 Milliamperage 1.6 Type screen B-2	1.5	10.0	Good, fair on thick soles
7. Primary voltage 110 Milliamperage 1.2 Type screen B-2	1	9.6	Fair, poor on thick soles Good on woman's shoe

*All r measurements were made at approximately the center of the floor of the foot chamber and were not made within a shoe.
**High intensity type screens must be used for best results.

From these data and other considerations it was decided that a beam intensity of 12r per minute was sufficient to give a satisfactory image of the feet in all but extremely thick soled shoes. This value was adopted as a maximum permissible beam intensity. Several observers agreed that five seconds was ample time in which to note the fit of a shoe and this time interval was chosen as the maximum duration of a single fitting. It thus became possible to state the permissible exposure for a customer in terms of the number of fittings allowed per day and per year, a statement easily understood by both shoe merchants and the public. Our regulations now state that the customer shall be warned to limit himself to five fittings in any one day and 20 fittings in a year. Within these limits the customer's feet will receive a yearly amount of radiation that will not exceed the equivalent of 0.1r per day and the whole body, even for small children, will certainly receive far less than do the feet. A further

safety factor is afforded by the variable absorption of x-radiation by the soles of the shoes. This was shown in some cases to reduce by more than 50% the amount of radiation actually reaching the foot. Table II shows the beam intensities found in a number of machines in use throughout the city. It also shows the satisfactory reductions effected by the manufacturers when new machines were designed to meet the regulations.

TABLE II.

Mfgr. of Machine	No. of Machines Measured	Av. Beam Intensity r/Min.	Min. Beam Intensity r/Min.	Max. Beam Intensity r/Min.
A	22	43	21	75
B	8	40	16	52
C	3	45	37	55
New machines delivered to meet regulations	10	11	6	19

Stray Radiation

IN GENERAL the primary beam intensities of old type machines are reasonably uniform and can be predicted to be between 30 and 40r per minute. Stray radiation cannot be so predicted for in this respect each machine is unique and expresses the care that went into its construction. Measurements of stray radiation were made at many locations within a radius up to 50 feet, but in order to achieve uniform checking, the five locations shown in Table III below, were chosen for routine measurement.

TABLE III.

Mfgr. of Machine	10 ft. Forward	Left Side	Right Side	Rear	Viewing Ports	Maximum Intensity at any of Positions
A	90	510	292	212	50	>2000
A, but designed to meet regulations	13	10	5	2	5	30
B	27	8	10	2	4	56
C	62	51	55	25	17	92
Two machines, with no tube enclosure	—	21,600	4800	2000	850	—
	350	>2,000	400	>2000	160	—

The measurement at 10 feet forward represents a compromise between ideal control and the degree of control that is attainable without resorting to cumbersome exterior shielding. By specifying that the customer's side of the machine must face an unoccupied area, exterior shielding becomes unnecessary.

On the basis of the data shown in Table III, the stray radiation intensity in the clerk's working zone is about 200 mr/hour. With an average viewing time of 30 seconds, a clerk thus receives 0.1r after 60 viewings. Ionization chamber measurements revealed that in addition to shoe clerks making fittings and industrial hygienists making the survey, cashiers and wrappers working in adjacent areas on occasion received exposures in excess of 0.1r per day. By decreasing the stray radiation intensity to 12.5 mr per hour and limiting the viewing time to five seconds, a much larger number of fittings is possible without excessive exposure to clerks.

Instrumentation

CONSIDERABLE STUDY was given to the selection of appropriate instruments for evaluating the x-ray exposures. Such devices must respond accurately to the long wave length radiation here encountered, within the five second operating period of the tube, and adequately cover the range of intensities encountered. Most Geiger-Mueller type counters do not comply with the above requirements. Ionization chambers of 0.1r capacity are satisfactory for evaluating the daily radiation received by exposed workers, and 0.1r chambers can be employed for evaluating stray radiation. The latter are both cumbersome and tedious to use. Ionization rate meters scaled from 0-2000 mr per hour are satisfactory for measuring the stray radiation if provided with rapid response circuits. Most of the measurements in this study were made with a Beckman MX-2 instrument. Direct beam measurements were made with a Victoreen condensor-r meter using recently calibrated 25 and 100 r chambers.

Regulations

THIS STUDY resulted in the establishment of Requirements for the Safe Operation of Fluoroscopic Shoe Fitting Devices, which in the light of present knowledge, will adequately protect both employees and customers. They are in close harmony with the New York City Ordinance and are believed to be generally applicable. These requirements and explanatory notes are as follows:

Requirements For The Safe Operation Of Fluoroscopic Shoe Fitting Devices

I. General

The hazards to health attendant on the operation of x-ray units are well known, and examples of injuries to x-ray technicians and others exposed to x-radiation are easily found. Fluoroscopic shoe fitting devices are specialized examples of x-ray units, and hence if not properly safeguarded, are capable of inflicting injury to both salespeople and customers.

These instructions are the result of investigations made on all makes of fluoroscopic shoe fitting machines extant in Detroit. Advice and assistance has been given by certified radiation physicists and reputable manufacturers of x-ray equipment. In addition, the views of both shoe merchants and fluoroscopic shoe fitting machine manufacturers have been considered. Two broad classifications will be made, regulations pertaining to the direct beam, of significance mainly to customers, and regulations pertaining to stray radiation, of significance mainly to working personnel.

II. Primary X-Ray Beams

a) Intensity

1. The greatest intensity of the direct beam, measured on the base of the foot opening, shall not exceed 12 roentgens per minute.
2. Two other intensities of less than 12 roentgens per minute shall be provided, one of sufficient strength to allow the fitting of women's shoes and the other of sufficient strength to allow the fitting of children's shoes.

b) Filtration

1. The floor of the foot opening shall be provided with a sheet of aluminum at least 1 mm. thick and of equal or greater dimensions than the floor. The aluminum filter must not be part of the wearing surface of the floor and must be installed so that its thickness can conveniently be determined.

c) Control

1. A reliable timer shall be provided that will limit the maximum exposure to five seconds.
2. A means shall be provided for making fittings at each of the three intensities previously listed. The words CHILDREN, WOMEN and MEN shall be posted to designate the lowest, intermediate and greatest intensities respectively.
3. The starting mechanism shall be of sufficient complexity to prevent operation by most customers.

III. Control of Stray Radiation

a) The x-ray tube shall be so shielded that stray radiation is reduced to less than 12½ milliroentgens per hour at all positions to the rear (operator's station), sides, and top of the cabinet. Measurements will be made within six inches of the cabinet and at eye level on the viewing ports.

b) The foot opening in the cabinet shall be so constructed and shielded that stray radiation at a distance of 10 feet forward shall not exceed 12½ milliroentgens per hour.

IV. Warning and Instruction Signs

a) A warning placard to be furnished by the Detroit Health Department shall be posted on the customer's side of each shoe fitting machine. This placard will be worded as follows:

WARNING

Exposure to x-ray may be harmful. Customers must not operate this machine. Limit for each customer: 5 x-ray shoe fittings per day, yearly total not to exceed 20 fittings.

b) A list of instructions for the safe operation of shoe fitting machines, to be furnished by the Detroit Health Department, shall be posted on or near each machine (see below).

V. Electrical Safeguarding

a) All metal non-current carrying parts must be grounded in accordance with the regulations of the Electrical Bureau of the Detroit Department of Buildings and Safety Engineering.

b) An interlocking switch must be provided on the container housing the x-ray tube. This switch must operate to break the electrical circuit whenever the container is opened.

c) Any alteration of the electrical circuit must be made by a licensed electrical contractor.

Safe Operation of X-Ray Shoe Fitting Machine

Misuse Of This Machine May Result In Injury To Either The Operator Or

THE CUSTOMER. THE FOLLOWING INSTRUCTIONS MUST BE CLOSELY OBSERVED:

1. Locate machine as far as possible from frequently occupied areas. Employees who work in one location only, such as cashiers and wrappers, must not be stationed in front of the machines, at any distance. Employees who do not spend their time in one location, such as salesmen, should not regularly perform duties within 10 feet of the front of the machine.

2. Limit the viewing time to the shortest time necessary to accomplish the fitting.

3. Restrict total exposure time for any one customer in any one day to 25 seconds (five fittings).

4. Each observation must be limited to five seconds or less. Do not use the machine as a device for demonstrating fit or lack of fit to the customer, the customer's relatives or friends.

5. The operation of the machine by customers must be strictly prohibited.

6. The operator of the machine must not use his own feet or hands for demonstrating x-ray fluoroscopy. Children's feet must not be held in position by an employee unless his hands and arms are protected by leaded gloves made for use in fluoroscopy. Such positioning of feet is preferably done by a parent or friend of the child.

7. The customer must have shoes on *both* feet at the time of a fluoroscopic examination.

8. The Bureau of Industrial Hygiene of the Detroit Department of Health, will be glad to provide assistance to owners of fluoroscopic shoe fitting machines in Detroit.

NOTES ON X-RAY FITTING MACHINE REGULATIONS

1. The generally accepted tolerance dosage of x-radiation is 0.1 roentgen per day (or 12.5 milliroentgens/hr) for persons continually exposed to such radiation. Because the trend is toward lower limit values as more information becomes available, the number of x-ray fittings made daily will not be considered. In other words, it will be assumed that the unit could be used continuously.

2. The limiting intensity of 12 r/min in the primary beam will not be measured within a shoe.

3. Beam intensities for children's and women's settings are not specified as they will depend largely on the characteristics of the individual transformers. They should be as low as good screen image will allow. It is known, for example, that an intensity of 9 r/min is sufficient for a good image of the average woman's foot and shoe.

4. Although other materials will give filtration equivalent to one millimeter of aluminum, aluminum is specified in order that uniformity of conditions may be realized.

5. A supplementary "off-on" switch or slide mechanism is considered sufficiently complex.

6. Effort should be made when shielding to reduce the intensity of radiation to less than 12.5 milliroentgens/hr directly in front of the machine.

7. Although not specified in these regulations, it is advisable that the latest type of fluoroscopic screen available be used. Older screens will give inferior images at the beam intensities permitted.

8. It is not felt necessary to require that a milliammeter or other indicating meter be part of the unit. Changes in the operating conditions of the x-ray circuit should be made by an x-ray engineer, and correlated with beam intensity measurements made by a suitably qualified person.

9. It appears desirable to accomplish the reduction of beam intensity by using the highest kilovoltage and lowest milliamperage consistent with good image formation, together with adequate filtration.

Radiation Hazards in Industry

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HEALTH PHYSICS is a new field of science, a specialized branch of radiology which first originated as a study in its own right during the summer of 1942. It was composed of physicists, chemists and engineers, who dedicated themselves to the study of radiation problems and the development of means by which radiation exposure to humans can be kept to a minimum. The measure of its achievement is that no one of the thousands of people engaged in the plutonium projects (Oak Ridge and facilities, Argonne National Laboratory, and Hanford Works) has received any radiation damage so far as most careful instrument measurements and the medical profession are concerned.

Radiations as referred to include x-rays, gamma rays (which are simply high energy x-rays) beta radiation which consists of high speed electrons, alpha particles which are charged helium nuclei, and neutrons. Cosmic rays are a mixture of various particles and radiations which come from outer space originating in the annihilation of atoms in distant suns, including our own. Because of the 93 million miles to our sun and the many light years to other stars the amount of cosmic radiation which strikes our earth is fortunately very small. We are additionally protected by the blanket of air about our earth and the deflecting effect of the earth's magnetic field.

It is one of the prices of progress that new discoveries, such as x-rays and natural radioactivity in the past, and the more recent atomic energy advances are attended by new risks and new hazards potential in their misuse through ignorance, neglect or carelessness. Mankind, according to one report, with only two pounds of radium in a comparatively few years, has succeeded through carelessness and ignorance in producing about 18 deaths and injuring many more people. Likewise many people have been injured and have died as a result of the early misuse of x-rays. Even today the careless use of x-ray continues to take its toll of damage.

Considering the different sorts of damage to man resulting from radiation, first might be cited damage to skin (or erythema) characterized by reddening—a dermatitis or inflammtaion of the skin which may be followed as a result of further exposure, by a condition of slow healing wherein damaged skin tissues may fester and form ulcers or even lead to conditions of cancer. Damage from radiation results also to the blood forming organs of the body, particularly the bone marrow and may result in conditions leading to anemia etc. Damage occurs also to the reproductive organs and the incidence of ovarian tumors in certain biological animals has been found to increase markedly with radiation exposure. Genetic damage likewise occurs from radiation and is perhaps less easily seen, since most mutants do not survive because mutations are usually unfavorable ones. In such cases the organism would not develop to the point of birth. While such effects may be anticipated from severe exposure, chronic exposures are also harmful, producing conditions of low resistance to disease. Chronic exposure can also produce cancer, leukemia and accellerated aging effects so that chronic exposure to unnecessary radiations may lead to death at an earlier age, than otherwise. This has been borne out quite strikingly in biological experiments, particularly with mice, where a close correlation is found between radiation exposure and a decrease of their life's span.

WE HAVE LONG known that we could get bad burns from our greatest source of atomic energy, the sun. Ultra-violet exposure in this case is different for it is recognized shortly after or during its occurrence. High energy radiations however are very penetrating and produce damage to tissues throughout the body. Those radiations of lesser energy are equally as bad if arising from radioactive materials

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which have gotten inside the body. Unlike the case of sunburn we have no sixth sense to warn us during or before the receipt of a possibly serious exposure from high energy atomic radiations. To protect us we must use instruments.

Instruments which detect high energy radiations are based in operation, on the fact that the energy of the radiations is utilized to form ions and these instruments are ionization measurement instruments. Perhaps the best known radiation detection instrument from newspapers, magazines, and the popular press is the Geiger-Mueller or the G-M tube. Recently newspaper articles have appeared suggesting that it is possible to rig up an adaptation to your own radio with a low voltage G-M tube so that you could hear contamination from any potential atomic bomb in the remote vicinity. The G-M tube is basically quite simple. It has high sensitivity and is quite useful in locating the presence of radiation by employing a scanning technique but it has the following disadvantages: (1) Limited lifetime, (2) Changes in calibration with its use, (3) Photosensitive and thermally sensitive, (4) Jamming to give false readings of zero instead of what should be very high readings, thus failing at the very worst possible time, and (5) Dependency on the energy of the radiation thus failing to give a true dosage value.

Instruments other than the G-M tube should be used for quantitative measurements for evaluations of radiation present. Such other methods or instruments would include the Lauritsen electroscope used with a stop watch to determine the radiation quantitatively. Film may be used to detect and to evaluate radiation. There is a special du Pont pack of film suitable for personnel usage to monitor the individual exposure received. Film appropriately shielded can be placed about the working area and give data on the amount of stray and leakage radiation thereabouts. Film disks can be placed in suitable rings and worn to give data on exposure received upon the hands.

With shielding, film as a badge can be worn by personnel and a careful interpretation of the darkening behind the shielding as compared to the unshielded film will give a qualitative estimate of the nature of the radiation present.

Pocket ionization chambers are very useful for measuring radiation. They consist simply of a fountain pen sized condenser with a central electrode which is initially charged to 150 volts. At the end of the working day the remaining charge on the pocket ionization chamber is read and since the loss of charge occurs as a result of the ionization the remaining charge on the pocket ionization chamber is read and since the loss of charge occurs as a result of the ionization within the chamber allowing the charge to leak off, this difference in charge permits an estimation of the radiation exposure during that day.

To evaluate the hazards of airborne activity, air samples are collected either by electrical precipitating methods or special filter paper methods to determine the airborne activity, and even the use of a suitable vacuum cleaner will enable airborne activity to be estimated by collecting dust which may be counted by using appropriate counting technique. In instances where personnel may have ingested radioactive materials, it is possible to examine urine specimens and estimate the extent of the radioactive materials in the body.

THE RESULTS of an extensive program of AEC sponsored research and new instrument development, especially at ORNL are being made available to commercial industrial companies for development of new instruments and to further their availability to all. Examples of this might be the radiation survey meter developed by Sylvania and instruments by many other companies. In situations where x-rays of high voltage are used in industry it is to be recommended that a competent radiologist from a local hospital be consulted to estimate the exposures being received. At ORNL we have a consultant in Health Physics, who occasionally might be available for consultation in unusual cases involving the use of considerable amounts of radioactive materials in industry. Such consultation services might be obtained through a request to the local AEC representative.

Having determined the amounts of radiation present, the amount permissible is the next consideration. Currently used values for maximal permissible exposure are 100 milliroentgen (mr)/day in the U.S., 50

mr/day in Canada and in some parts of Europe 200 mr/day. Based on more recent biological work and calculations, a revision is pending to change the current value from 0.5 roentgen (r)/week or 0.1 r/day to a reduced 0.3 r/wk so that any possibility of shortening of life span can be more completely avoided.

Maximal permissible exposures are in general based not only on past tragedies in x-ray and radium work but also on extensive biological experiments using test animals of different sorts and are generally difficult to establish because of a number of factors. First, there is an individual variation of radio-sensitivity from person to person. Another factor is the dependence of the tolerant dose on the energy of radiation. More of low energy radiation can be tolerated than of high energy radiation. Third, is the influence of the rate at which the radiation dosage is given. It is less damaging to take a large total dose a little at a time over a considerable length of time than greater amounts at less frequent intervals. Fourth, the relative damage by radiation to local body area differs when contrasted with similar amounts of radiation if applied to the total body. There are also effects of radiation with particularly genetic effects and those pertaining to reproductive organs for which no threshold dosage exists. Because of these factors, the maximal permissible exposures should always allow a certain factor of safety. Contrasted with a maximal permissible exposure of 0.1 r/day which if received throughout a lifetime would produce no harm, the records at ORNL show that no employee averages more than 0.02 r/day.

There is a natural background of radiation present everywhere throughout the world and this background varies from time to time at the same place and from place to place by factors of ten or more. While natural radiation may not do man any good, nevertheless, we have survived and developed in the presence of this natural radiation and it certainly may be assumed that values comparable to this, cause no more harm than, for example, the use of tobacco or other similar habits. Quantitatively the natural background is about 1/400 of what has been established as the tolerant amount of radiation dosage and is of the order of 0.01 mr/hr. The source of different natural backgrounds, in addition to cosmic rays, consists of the naturally radioactive materials which are widely distributed through the rocks and materials of the earth. The average composition of the earth's crust is such that we have 1.3×10^{-12} grams of radium per gram of rock on the average. There are also other radioisotopes giving off radiation present in our environment such as K^{40} and C^{14} which is produced by the action of cosmic ray neutrons on the nitrogen in the air.

IN GENERAL, the following steps should be taken to control exposure to radiation:

(1) Protection may be achieved by limiting the length of time of exposure; that is, only the minimal length of time necessary should be spent near any radioactive materials.

(2) Increase the distance from the source of radiation. Do not get any closer to radioactive materials than necessary.

(3) Use radiation shielding materials. For example, x-rays are often shielded by small thicknesses of lead.

(4) Use care in disposing of radioactive materials. For example, do not simply pour any solutions of radioactvie isotopes down the drain and flush them with water since such radioactive materials quite often exchange with the metal surfaces of the pipe and plate out, constituting a potential hazard to some future plumber.

(5) Wherever there is a possibility of radioactive materials contaminating dust so that they can become airborne use adequate ventilation.

(6) Know the radiation strength of the materials you are using, check the radiation intensity with suitable instruments.

(7) Insist that your employees working with radioactive materials who may possibly become exposed wear film badges and pocket ionization chambers so that any exposure that they may receive can be verified and recorded. This will serve as a protection from a legal standpoint both for employer and employee.

(8) Have periodic blood counts made of employees frequently subject to exposure to radiation to determine any effect of large exposures to radiation on their blood.

WITH INCREASING and anticipated widespread use of radioactive materials in

industry we need to have a clear understanding and full appreciation of the health physics problems to be encountered. You should acquaint yourselves with tolerant levels of different sorts and with instruments used in measuring radiation and their operation. This will assuredly take time. For example, the Army does not give the soldier a few months training with a knife and then have him serve as a surgeon. A bibliography of material, where reliable information can be obtained is being appended.

An authoritative book on the subject of health physics by Dr. K. Z. Morgan of ORNL will soon be published. A professional course in health physics is being given under the sponsorship of the Atomic Energy Commission. While the first students are primarily medical men, it should be anticipated that industrial hygienists most appropriately should be included in repetitions of this course. A practical course in applied health physics of perhaps more elementary level is currently being given at ORNL and may be issued in manual form by the AEC at some future date.

Becoming thus fortified with reliable information for evaluation of radiation hazards, you will be in the best position to safeguard industry in the use of radioactivity during peacetime, and in the event of an atomic war, you will be a valued and necessary bulwark to our nation's protection.

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American Industrial Hygiene Association

—News of the Local Sections—

Northern California Section

THE FIRST annual meeting of the Northern California Section, AMERICAN INDUSTRIAL HYGIENE ASSOCIATION, was held in Berkeley on December 1, 1948. The Section has 17 active members, and approximately 25 guests attended the dinner and program which were held after the business meeting. Mr. Bernard T. Tebbens discussed the problems encountered in his stay in Peru and Bolivia, and later Dr. Francis R. Holden, Industrial Hygienist for the San Francisco Naval Shipyard, discussed some of the problems encountered there, especially in dealing with radioactive materials.

Plans have been set up for enrolling as Associate Members persons who have professional interest in industrial hygiene but are not eligible for the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION. Another meeting is planned for January 31, 1949.

Chicago Section

AT THE DECEMBER meeting, Dr. W. E. Grove of Milwaukee, Wisconsin, presented an address entitled "The Noise Hazard."* Dr. Grove is chairman of the Sub-Committee on Industrial Noise of the Committee on Conservation of Hearing of the American Academy of Ophthalmology and Otolaryngology.

The January meeting is to consist of a seminar on industrial hygiene problems. Questions which members wish discussed are to be sent to the Secretary prior to the meeting and members are also invited to bring problems to the meeting and join in the discussion. The panel will consist of the following members: Dr. H. H. Steinberg, International Harvester Company; Dr. E. H. Carleton, Inland Steel Company; Miss Joan Ziano, R.N., Illinois Department of Health; Mr. K. M. Morse, Illinois Department of Health; F. A. Van Atta, Ph.D., National Safety Council; Mr. A. D. Grossi, Illinois Department of Labor; Mr. C. W. Wyman, Western Electric Company.

Dr. Joseph A. Hubata, Medical Director, Armour and Company, will address the February meeting. His subject is entitled: "Packing House Magic."

*Published in INDUSTRIAL MEDICINE, 18:25-28.

New England Section

THE NEW ENGLAND SECTION held an all-day meeting on November 5, at the Aetna Life Affiliated Companies, 151 Farmington Avenue, Hartford, Connecticut. Albert S. Gray, M.D., Director, Connecticut Bureau of Industrial Hygiene, was Chairman. At the conclusion of the program a business meeting was held and officers were elected for the ensuing year.

Georgia Section

DURING the past year the Georgia Section has held meetings as follows:

March, 1948: Dr. E. F. Lutz of the General Motors Corporation presented "The Plant Physician's Responsibility in Industrial Hygiene."

June, 1948: Dr. Charles R. Williams of the Liberty Mutual Insurance Company spoke on "Radiation Hazards in Industry."

October, 1948: Dr. Clarence D. Selby, Consultant for General Motors Corporation, presented "General Motors Medical Program." At this meeting the annual election of officers was held and the following were elected:

President, Prof. H. A. Wycoff, Georgia Institute of Technology; Vice President, Mr. Roy B. Hendon, Liberty Mutual Insurance Company; Secretary-Treasurer, Dr. L. M. Petrie, Georgia Department of Public Health.

Metropolitan New York Section

ELECTED for 1949 were: Chairman-Elect, Frederick W. Sands; Secretary-Treasurer, John J. Ferry; Councilors, C. B. Ford and Dr. Willard Machle.

At the meeting to be held February 9, in New York City, Dr. William B. Deichmann, Medical College, will speak on "Local and Systemic Effects following Skin Contact with Phenol."

Michigan Section

AT THE September 29 meeting, H. M. Archer and R. E. Bandfield of the Detroit Edison Company spoke to the Michigan Section on "Industrial Hygiene Problems of Ultraviolet, Infra-red and Illuminating Installations."

At the meeting on October 22, Gordon C. Harrold, Ph.D., discussed "The Control of Health Problems Associated with the Use of Solders." This discussion included the fluxes used in these operations.

At a dinner meeting and dance held on November 29, Lt. Albert Langtry, Detroit Police Scientific Laboratory, addressed the group on "Scientific Criminal Investigation."

A panel meeting on industrial hand soaps and protective creams is planned for December. Representatives of soap and protective cream manufacturers will be included on the panel.

Current officers of the Michigan Section are: President, Wm. G. Fredrick, Sc.D.; President-Elect, Ira Aurin, M.D.; Secretary-Treasurer, Walter H. Konn.

Northeastern Ohio Section

THE FIRST MEETING of 1948-49 season was held September 29 at the Cleveland Bureau of Industrial Hygiene. Commissioner Herbert Dyktor explained the organization of the Cleveland Division of Air Polution Control. The remainder of the meeting consisted of an informal inspection of the facilities of the Cleveland Bureau of Industrial Hygiene and included demonstrations of the collection and analysis of various air contaminates. Ventilation demonstrations and microscopic slides of various types of dusts encountered in industry were also shown. Approximately 40 persons were present.

Pittsburgh Section

ON DECEMBER 14, 1948 Mr. H. W. Speicher of the Westinghouse Industrial Hygiene Department will speak to the Pittsburgh Section on Atomic Radiation. Mr. Speicher spent one year in residence at Oak Ridge. On January 11, 1948 there will be a joint meeting with the members of Phi Sigma, Alpha Epsilon Chapter, University of Pittsburgh, to hear Oscar W. Richards, Research Supervisor for Biology, American Optical Company, discuss "Phase Microscopy." Both meetings will be held at the Bureau of Mines, 4800 Forbes Street. Officers of the Pittsburgh Section are: Chairman, C. H. Mehaffey, Mine Safety Appliance Co.; Vice Chairman, J. H. Holden, Pittsburgh Testing Laboratory; Secretary-Treasurer, C. P. Carpenter, Mellon Institute.

Tennessee Section

THE ANNUAL meeting was held December 4, 1948, at the Doctors' Building Auditorium, Nashville. During the morning session the following papers were presented:

The Energy in Color and the Part It Plays in a Safety Program: Norman Jordan, Pittsburgh Plate Glass Company.

Color Perception: Dr. Beverley E. Holaday, University of Tennessee.

Radiation Hazards in Industry*: T. H. J. Burnett, Oak Ridge National Laboratory.

Continuous Carbon Monoxide Recorder: Stanley C. Kyle, Tennessee Valley Authority.

The officers are as follows: Dr. W. N. Dawson, President, Aluminum Company of America; Frank Oglesby, President-Elect, Tennessee Eastman Corporation; Francis P. Jung, Secretary-Treasurer.

Present plans for future meetings in 1949 are to hold a spring meeting in Memphis, Tennessee, on or about March 18, 1949, and possibly a summer meeting in Oak Ridge, Tennessee, sometime in July or August in addition to the Annual 1949 meeting in Nashville.

Washington-Baltimore Section

THE OCTOBER meeting was held on the 27th, at the Officers' Club, Naval Gun Factory, Washington. Dr. J. G. Townsend, Chief, Industrial Hygiene Division, Public Health Service, gave a resume of the Ninth International Congress on Industrial Medicine, held at London, and Mr. Hilton Brown, Health and Safety Branch, Bureau of Mines, College Park Station, gave a review of recent explosions in industrial plants.

At a meeting held on December 15, also at the Officers' Club, Captain Albert R. Behnke, National Naval Medical Center, Bethesda, Maryland, discussed "Nutritional Problems in the European Area with Special References to Industrial Output."

The officers for 1948 are as follows: Chairman, Mr. C. E. Couchman, Baltimore City Department of Health; Vice Chairman, Dr. Lewis J. Cralley, Public Health Service; Secretary-Treasurer, Mr. R. G. Keenan, Public Health Service; Members-At Large, Dr. W. H. Schulte, Baltimore City Department of Health; and Dr. W. M. Gafafer, Public Health Service, Washington, D.C.

*Published in this issue.

For 1949, the Nominating Committee has submitted the following slate: Vice-Chairman, Dr. Wm. F. Reindollar; Secretary-Treasurer, Mr. C. D. Yaffe; Member-at-Large, Capt. W. K. Sessions.

New Jersey, Philadelphia and Metropolitan New York Sections Joint Session

THE JOINT meeting of the Metropolitan New York, New Jersey, and Philadelphia Sections held a year ago in Trenton, New Jersey, was so successful that a similar meeting was held this year in New York on December 10, 1948.

The program was as follows:

Chairman: Leonard J. Goldwater, M.D., Professor of Industrial Hygiene, Columbia University School of Public Health.

Industrial Toxicology: Lawrence T. Fairhall, Ph.D., Scientist-Director, Laboratory Unit, Division of Industrial Hygiene, U.S. Public Health Service, Bethesda, Maryland.

Methods of Sampling Large Volumes of Air: William B. Harris, Health and Safety Branch, United States Atomic Energy Commission, New York, New York.

A Preventive Medical Armor for the Lead Industry: F. B. Lanahan, M.D., Medical Director, Electric Storage Battery Company, Philadelphia, Pennsylvania.

Lung Cancer in Chromate Workers: Willard H. Machle, M.D., Clinical Professor of Medicine, New York Medical College.

The Donora Disaster:* Joseph Shilen, M.D., Director, Division of Industrial Hygiene, Pennsylvania Department of Health, Harrisburg, Pennsylvania.

Cyanide, Its Effect, Control and Determination:** Norman White, Supervisor of Industrial Health and Toxicology, Merck and Company, Rahway, New Jersey.

Following the dinner, the three sections were addressed by Dr. Anthony J. Lanza, Chairman, Institute of Industrial Medicine, New York University, Bellevue Medical Center.

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Medical Advisory Committee on Beryllium

WITH THE important position of beryllium and its compounds in a number of industries together with the great complexity and severity of effects on health of persons working with these materials, it is most fortunate that a medical advisory committee has been set up composed of able men closely associated with the several aspects of the situation. These include the fields of industrial hygiene administration, industrial medicine, pathology, toxicology, and industrial hygiene engineering. The membership of this committee which has been studying the results of work on beryllium over the last three years is as follows: Dr. James G. Townsend, Chief of the Division of Industrial Hygiene of the Public Health Service, chairman; Dr. M. G. Carmody, Clifton Products Company, Painesville, Ohio; Dr. T. L. Hazlett, Westinghouse Electric Corporation, Pittsburgh, Pennsylvania; Dr. J. M. DeNardi, Brush Beryllium Company, Cleveland, Ohio; Dr. W. H. Machle, Sylvania Corporation, New York, N.Y.; Dr. A. D. Nichol, General Electric Company, Nela Park, Cleveland, Ohio; Dr. A. J. Vorwald, Director, The Edward L. Trudeau Foundation and the Saranac Laboratory, Saranac Lake, New York; Mr. C. R. Williams, Industrial Hygiene Field Service, Liberty Mutual Insurance Company, Boston, Massachusetts; Dr. B. S. Wolf, U.S. Atomic Energy Commission, New York, N.Y.; and Dr. Harry Tebrock, Medical Director, Sylvania Products, Long Island, New York.